

Chapter 3

Clinical Informatics

Learning Objectives

At the conclusion of this chapter, the reader will be able to:

- Identify basic clinical vocabulary/terms frequently represented in healthcare informatics (e.g., dosage frequency, dosage routes, body systems)
- Identify basic healthcare IT vocabulary/terms frequently represented in healthcare informatics
- Identify basic clinical metrics frequently represented in informatics (e.g., average daily census, turnaround time, adherence, barcode medication administration)
- Develop and implement system functionality to optimize clinical effectiveness and efficiencies
- Interpret clinical and operational outcomes through the use of various data analytics tools (e.g., reports, tables, graphs, charts, predictive models)
- Develop mechanisms to facilitate ongoing clinical content and decision-support tools

Introduction

Clinical informatics is a vast and diverse study of information technology (IT) and how it can be applied to the healthcare field. HIMSS defines clinical informatics as the promotion of “understanding, integration and application of information technology in healthcare settings to ensure adequate and qualified support of clinician objectives and industry best practices.”¹ The field includes²:

- Methods to collect, store and analyze healthcare data
- The study of information needs and cognitive processes and optimal ways to meet those needs

- Methods to support clinical decisions, including summarization, visualization, provision of evidence and active decision support
- Optimizing the flow of information and coordinating it with care providers' and patients' workflows to maximize patient safety and care quality
- Methods and policies for information infrastructure, including privacy and security

Globally, clinical informatics has been increasingly impactful to the healthcare world. Diana Nole, the Chief Executive Officer (CEO) of Wolters Kluwer Health, states that in 2018 there was more than US\$ 8 billion in digital health deals made.³ Clinical decision support (CDS) continues to be a powerful tool in providing guidance to today's clinicians. Drug usage and cost is being looked at with new eyes through data, and artificial intelligence (AI) and machine learning adoption are on the rise. With the increased focus on social determinants of health and patient-driven care, AI will development and usage will continue well into the future.³ And clinical informaticists will be needed to maintain their role as translators in the interprofessional team, as a professional that speaks both informatics and healthcare.

As discussed in [Chapter 1](#), “Healthcare Environment,” often considered a hybrid of many different informatics models and theories, clinical informaticists can consist of physicians, nurses, pharmacy, laboratory, radiology and other clinical professions. Physicians and nurses make up the largest group of healthcare professionals, “who have actively contributed to and advanced the theory and practice of clinical informatics.”⁴ Nurses established an early role as clinical informaticists, with certifications starting in 1992.⁴ Physicians later followed with their own certifications through the American Medical Informatics Association (AMIA) in 2013.⁵ HIMSS, Certified Associate in Healthcare Information and Management Systems (CAHIMSSM) and Certified Professional in Healthcare Information and Management Systems (CPHIMSSM) are listed among the highest recommended informatics certifications for clinicians, as well as board certifications. Acquiring a certification is recognized as a “highly-visible quality indicator and a tool to improve recognition among peers.”⁴ [Table 3.1](#) takes a look at the differences between nursing and physician certification processes.

Global Aspects of Clinical Informatics

Although many items referenced in this chapter are centered around the United States, clinical informatics is very global. Global clinical informatics is a fast-growing, interdisciplinary field. From privacy and security issues to global population health, clinical informatics professionals have a great impact on the management of patient health data.

Health information data can be stored across borders, which allows for the impact of international law with both the data usage as well as patient's rights.⁶

Table 3.1 Comparison of Informatics Certification Processes for Nurses and Physicians⁴

	<i>Nursing Informatics Certification Informatics Skills/Competencies References</i>	<i>Clinical Informatics Board Certification for Physician* Informatics Skills/Content Outline References</i>
Skills and Competencies	Scope of nursing informatics practice: foundational knowledge of metastructures, concepts and tools, functional areas of nursing informatics; evolution of informatics competencies, ethics, the future of nursing informatics including trends in practice roles, technology, regulatory changes and quality standards, care delivery models and innovation. Standards of nursing informatics practice: assessment, diagnosis, problems and issues, outcomes identification, planning, implementation, evaluation standards of professional performance for nursing informatics: ethics, education, evidence-based practice and research, quality of practice, communication, leadership, collaboration, professional practice evaluation, resource utilization, environmental health	Informatics competencies as listed on the outline for board certification: leading and managing change, health information systems, fundamentals of informatics, clinical decision-making and care process improvement, legal, ethical and regulatory issues
Eligibility	Eligibility is limited to nurses with a baccalaureate degree in nursing; current R.N. license; two years' experience practicing as a Registered Nurse; experience practicing as an informatics nurse and/or graduate-level practicum hours in informatics	Eligibility is limited to physicians with MD or DO degree; current, unrestricted medical license in the United States; current American board certification in primary clinical discipline or pathology
Practice Requirement	ANCC certification requires up to 2000 hours of experience in informatics nursing. Practicum hours in a graduate nursing informatics program may also be used to satisfy the practicum requirement.	Accredited fellowship: 2 years Practice Pathway (25% time spent in informatics related activities for at least 36 months in the 5 years or acceptable 24-month informatics master or fellowship prior to taking the examination)

(Continued)

Table 3.1 (Continued) Comparison of Informatics Certification Processes for Nurses and Physicians⁴

	<i>Nursing Informatics Certification Informatics Skills/Competencies References</i>	<i>Clinical Informatics Board Certification for Physician* Informatics Skills/Content Outline References</i>
Validation Domain	Certification validates knowledge pertaining to the informatics nurse role; informatics nurse specialists, those with graduate degrees in informatics, practice at higher levels than that implied by certification	Board certification validates practice-based training and experience and/or formal training in clinical informatics (either advanced degrees or fellowships)
Duration of Validity	Board certification valid for five years	Board certification valid for 10 years
Recertification	A minimum of 30 hours continuing education in informatics required for initial certification. Continuing education also required for re-certification.	Continuing education needs for maintenance of certification; requires examination once every 10 years

This requires not only a strong healthcare system and regulatory knowledge for the country of origin but any foreign locations as well.

Several global initiatives share the mission of increasing clinical informatics education and best-practices. The AMIA leads a global health informatics working group (GHIWG) designed to work with resource-constrained countries. They work to increase overall informatics usage and facilitate collaborative efforts between clinical informatics workers. Their connection forum helps to facilitate the exchange of both informatics experiences, as well as expertise, across the global spectrum.⁷

HIMSS has always had its North American roots. Within that scope, it includes the digital health support of Canada, including its own HIMSS certification (CPHIMS-CASM). Digital health is a term for clinical informatics more commonly used outside the United States. Through HIMSS, “international insights, resources, and audiences” are provided at the ready for the Canadian clinical informatics professionals.⁸ The Canadian/HIMSS collaboration currently concentrates in three areas⁸:

1. Strengthening the HIMSS Ontario Chapter (ON Chapter) through increasing the Canadian health association presence in HIMSS activities, volunteer opportunities and project that will aid both Ontario's, as well as HIMSS, global digital health influence.
2. Support existing associations and Canadian digital health initiative by including (and sponsoring) local informatics groups such as the British Columbia Health Information Management Professionals Society (BCHIMPS) and the Canadian Trade commission.

3. And by filling the void. HIMSS has the unique ability to bridge the clinical informatics gap and aid in increasing the knowledge and expertise of Canadian stakeholders. This is evidenced by its recent expansion efforts, including the formation of the Canadian Prairies Chapter of HIMSS to support other areas of Canada in a more local fashion.

Furthermore, since the publication of this chapter, HIMSS has also worked with local constituents to form the Canadian Prairies Chapter and with the BCHIMPS to form the HIMSS British Columbia Chapter.

Finally, there is the EU–US eHealth Work Project, which culminated its project work in May 2018. As a Horizon 2020 project, its goal was to “map skills and competencies, provide access to knowledge tools and platforms and strengthen, disseminate and exploit success outcomes for a skilled transatlantic eHealth workforce.”⁹ The 21-month project began in September 2016 with funding from the European Commission’s Horizon 2020 research and innovation grant program and came to a close in May 2018. Their challenge was to develop something that would expand the foundations already in place for digital skills and push the global boundaries of innovation and resource development. This included making sure that clinical informaticists were engaged and brought into the extensive stakeholder community. They achieved this through the development of the Consortium, which consisted of a network of partners in academia, healthcare associations, as well as healthcare providers, and industry workers. The Consortium included: Omni Miro Systems/Med Solutions (Germany) who served as the project coordinator, European Health Telematics Association (EHTEL) (Belgium), University of Applied Sciences Osnabrück (Germany), Tampere University of Technology (Finland), Steinbeis Zi GmbH (Germany),⁹ and the HIMSS Foundation with project fulfillment by the HIMSS Technology Informatics Guiding Education Reform (TIGER™) Initiative. To meet their goals, they conducted a survey (Survey of Current State and Needs of the eHealth Workforce) to identify the “real world” challenges and gaps in informatics. The study, which served as the flagship of the project, considered demographics with over 1,000 respondents globally, primarily from the United States (72%) and Europe (19%). One of the most significant results of the survey was the need for increased clinical informatics education, specifically with nurses, physicians and educators rounding out the top three. They released this as GAP1: eHealth knowledge and skills of healthcare professionals, with there being ten significant gaps identified in total. Other deficiencies consisted of gaps in teacher/trainer knowledge, acceptance and usage of systems, availability of course or programmes for education and the quality of current training materials for any clinical informaticist.⁹

The project also included an update of the Health Information Technology Competencies (HITCOMP) Tool to a 2.0 version. Seen as an innovative solution, this tool is available to the global clinical informatics community and concentrates on eHealth, digital skills research, education development, skills

assessment, and career progression. It contains over 1000 competencies, over 250 healthcare roles, in five major European languages.

The HIMSS TIGER Initiative continues its partnership with the project through support in several platforms such as the Foundational Curriculum and the Interactive Web Platform TRIE (tools, resource, information, education) (includes HIMSS TIGER Virtual Learning Environment (VLE)). Also, the skills and knowledge assessment and development (SKAD) framework promotes certification programs such as the HIMSS CAHIMS/CPHIMS.⁹

Domains of Clinical Informatics

With patient safety always paramount, “clinical informaticians transform healthcare by analyzing, designing, implementing and evaluating information and communication systems that enhance individual and population health outcomes, improve patient care, and strengthen the clinician-patient relationship.”¹⁰

According to AMIA (Figure 3.1), “clinical informaticians use their knowledge of patient care combined with their understanding of informatics concepts, methods, and tools to:

- Assess information and knowledge needs of healthcare professionals and patients;
- Characterize, evaluate and refine clinical processes;
- Develop, implement and refine clinical decision-support systems; and
- Lead or participate in the procurement, customization, development, implementation, management, evaluation and continuous improvement of clinical information systems.”¹⁰

In this chapter, we will take a deeper dive into the world for clinical informatics. Starting with the basics, we will review the language and definitions commonly

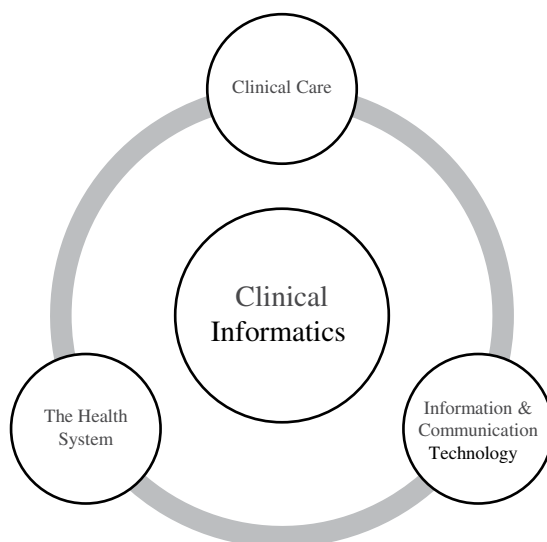


Figure 3.1 Domains of clinical informatics.¹⁰

used in healthcare. We will also examine clinical metrics frequently represented in informatics such as average daily census, turnaround time, adherence and barcode medication administration. To evaluate these metrics, often informaticists will need to use various analytical tools. It is essential to have a good understanding of clinical and operational outcomes through the use of tools such as reports, tables, graphs, charts and predictive models. Finally, in this chapter, we will review one of the most often used tools, and often debated, clinical content and decision-support tools.

Basic Clinical Vocabulary and Terms

Understanding the basics of healthcare is vitally important for health IT workers and clinicians alike. To be able to speak the same language, and understand each other, common ground must be found. In this section, we will review frequently used clinical terminology found in the healthcare environment. At the root of clinical language is the use of prefixes, letters, words, or numbers placed before a medical term. Any tables listed are merely a sampling of existing terminology; they are not meant to be a complete catalog ([Tables 3.2–3.6](#)).

Table 3.2 Frequently Used Clinical Terminology Prefixes^{11,12}

Brachi/o	<i>Arm</i>	Lapar/o	<i>Abdomen, loin or flank</i>
Cardi/o	<i>Heart</i>	My/o	<i>Muscle</i>
Cyt/o	<i>Cell</i>	Neur/o	<i>Nerve</i>
Derm/a, derm/o, dermat/o	<i>Skin</i>	Ocul/o	<i>Eye</i>
Encephal/o	<i>Brain</i>	Ophthalm/o	<i>Eyes</i>
Gastr/o	<i>Stomach</i>	Or/o	<i>Mouth</i>
Hemat/o	<i>Blood</i>	Ot/o	<i>Ear</i>
Intestin/o	<i>Intestine</i>	Pulmon/o	<i>Lungs</i>

Table 3.3 Common Drug Routes and Abbreviations¹³

<i>Classification</i>	<i>Drug Routes</i>	<i>Common Abbreviations</i>
Enteral	Oral	PO
	Sublingual	SL
	Per rectum	PR
Parenteral	Injections	SQ, IM, IV, IA, IT, IO, ID
Inhalation	Lungs	Aerosols, steam
Topical	Skin	Enepidermic, epidermic, insufflation, instillation, irrigation, swabbing

Table 3.4 Medical Specialties¹⁴

Allergy and Immunology	Allergies	A provider that specialized in diagnosis and treatment of allergies, including allergy testing, medications
Anesthesiology	Sedation/ anesthesia	Specializes in anesthesia, sedation and airway management. Typically seen in the operating room working with the patient during their surgery
Cardiology	Cardiovascular system	The provider treats heart and blood vessel issues and disease processes
Dermatology	Integumentary system	The provider delivers care from aesthetics (e.g., laser treatments) to rashes, skin cancers and other skin issues
Endocrinology	Endocrine system	Diseases such as diabetes and thyroid issues
Family Physician	Primary care provider	Providers deliver basic care (typically nonspecialized) for patients across all spectrums (genders and ages)
Gastroenterology	Digestive system	Providers works around the esophagus, stomach, intestinal issues including reflux, gallbladder, colitis, etc.
Infectious Disease	Infections	Difficult to diagnose or treat, such as tuberculosis, Zika, or Dengue
Internal Medicine	Primary care provider	Specialized providers that encompass sub-specialties such as cardiology or endocrinology
Neurology	Neurologic system	Works with spinal issues, brain, nerves. Some examples include Parkinson's and neuropathies
Pediatrics	Pediatric care	The care is given to younger patients, typically infancy through age 18. This includes well-checks, immunizations, physicals, etc.
Oncology	Cancer management	Providers care for cancer, side-effects of treatment, clinical trials and end-of-life care
Obstetrics/ Gynecology	Women's health	Reproductive care, preventive care (annual pap exams, mammograms), pregnancy, menopause, contraception and infertility
Otolaryngology	Ears, nose and throat	Most often, ENTs are also surgeons that cover areas from sinus issues, neck cancers, etc.
Psychiatry	Mental and behavioral healthcare	Providers work with patient counseling, psychotherapy, analysis, hospitalization and medications
Radiology	Imaging	A physician trained at interpreting diagnostic exams/ testing
Surgery	Surgical care	General or specialized surgical providers. Responsible for planning pre-operative needs, the surgery, post-operative needs, as well as any complications that may arise (e.g., orthopedics, general, bariatrics, etc.)

Basic Information Technology Vocabulary and Terms

Table 3.5 Frequently Used Clinical Abbreviations¹³

<i>Abbreviation</i>	<i>Definition</i>	<i>Abbreviation</i>	<i>Definition</i>
AM	Morning	L	Liter
AC	Before meals	LMP	Last menstrual period
AD	Right ear	MCG	microgram
Ad lib	Freely	mEq/L	Milliequivalent per liter
Amp	Ampule	mL	Milliliter
Ante	Before	Mm	Millimeter
AS	Left ear	N/V	Nausea and vomiting
ASA	Aspirin	NKDA	No known drug allergies
AU	Both ears	NPO	Nothing by mouth
BID	Twice a day	OD	Right eye
BMI	Body mass index	OS	Left eye
BP	Blood pressure	OU	Both eyes
BS	Blood sugar	oz	Ounce
CC	Chief complaint	PRN	As needed
Cap	Capsule	PM	Evening
CM	Centimeter	PMH	Past medical history
CXR	Chest x-ray	Q	Every
DC	Discontinue	Q2h	Every two hours
Disp	Dispense	Q6h	Every six hours
ER/EC/ED	Emergency room	Qam	Every morning
G	Gram	Qpm	Every night
Gr	Grain	QID	Four times a day
HR	Hour	QOD	Every other day
H/O	History of	Rx	Prescription
HR	Heart rate	SL	Sublingual
HS	At bedtime	SQ	Subcutaneous
HX	History	STAT	Immediately
ID	Intradermal	Supp	Suppository
IM	Intramuscular	T	Temperature
IN	Intranasal	TID	Three times a day
INJ	Injection	w/o	Without
IV	Intravenous	WNL	Within normal limits

Table 3.6 Frequently Used Healthcare Information Technology Vocabulary¹⁵⁻¹⁹

Affordable Care Act (ACA)	The comprehensive healthcare reform law in the United States enacted in March 2010, also known as “Obamacare”
Accountable Care Organization (ACO)	A group of healthcare providers who give coordinated care, chronic disease management and thereby improve the quality of care patients receive
Current Procedural Terminology (CPT®)	These codes are used for the billing of medical procedures
Digital Imaging and Communication in Medicine (DICOM®)	The Digital Imaging and Communications in Medicine (DICOM) Standard was developed for the transmission of images and is used internationally for Picture Archiving and Communication Systems (PACS)
Federally Qualified Health Center (FQHC)	Federally funded nonprofit health centers or clinics that serve medically underserved areas and populations
Health Information Portability and Accountability Act (HIPAA)	U.S. law designed to provide privacy standards to protect patients’ medical records and other health information provided to health plans, doctors, hospitals and other healthcare providers
Health Level Seven (HL7)	ANSI-accredited, a nonprofit, standard-developing organization that creates methods for interoperability of healthcare data interchange. It focuses on clinical and administrative data
Tenth revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10)	ICD-10 is a system used by physicians and other healthcare providers to classify and code all diagnoses, symptoms and procedures recorded in conjunction with hospital care in the United States
Logical Observation Identifiers Names and Codes (LOINC®)	Coding system for the electronic exchange of laboratory test results and other observations. LOINC development involved a public-private partnership comprised of several federal agencies, academia and the vendor community. This model can be applied to other standards setting domains
Merit-Based Incentive Payment System (MIPS) (U.S. based)	MIPS was designed to tie payments to quality and cost-efficient care, drive improvement in care processes and health outcomes, increase the use of healthcare information and reduce the cost of care

(Continued)

Table 3.6 (Continued) Frequently Used Healthcare Information Technology Vocabulary^{15–19}

Natural Language Processing (NLP)	Natural language processing (NLP) is a branch of artificial intelligence that helps computers understand, interpret and manipulate human language. NLP draws from many disciplines, including computer science and computational linguistics, in its pursuit to fill the gap between human communication and computer understanding
Systematized Nomenclature of Medicine-Clinical Terms (SNOMED CT [®])	SNOMED-CT (Clinical Terminology) has been created from the combination of SNOMED-RT (Reference Terminology) and Read codes
Unified Medical Language System (UMLS [®])	Developed by the National Library of Medicine in an attempt to unify disparate medical vocabularies and facilitate sharing medical knowledge across information systems

Common Clinical Metrics in Informatics

Most clinical informatics professionals will credit the birth of clinical metrics with the 1999 publication by the Institute of Medicine (IOM), “To Err is Human.” This landmark report brought to light issues within the healthcare system that not only was responsible for significant financial loss but also loss of life.²⁰ With the field of clinical informatics being vast in scope, certain areas set it apart from other types of IT. One is the focus of healthcare informaticists on the need for identification and adoption of clinical metrics. Since the IOM report, there has been a significant surge in the development of methods to help keep down cost, provide accessible healthcare, as well as significantly improve patient safety.

In the United States, the development of the American Reinvestment and Recovery Act (ARRA), the accompanying Health Information Technology for Economic and Clinical Health (HITECH) Act,²¹ and the Patient Protection and Affordable Care Act²² reinforced the shift in focus even more towards the goal of decreasing government spending on healthcare while also improving patient safety. These public laws, as well as the Centers for Medicare and Medicaid Services (CMS) introduction of Meaningful Use (MU), created a rapidly changing landscape for clinical informatics. Before the introduction of these laws, adoption was slow at best. But with the incentives provided by the HITECH Act, a landslide of implementation of certified electronic health records (CEHRTs) was kick-started.

CMS has had many variations since 2009, of the expectations of meeting their electronic clinical quality measures (eCQMs). These tools were designed to specifically aid in measuring and tracking several aspects of healthcare. The

reporting of these measures revolved around working the eligible providers (EPs), eligible hospitals, dual-eligible hospitals and critical access hospitals (CAHs). Per CMS (2019), their current version of meeting the guidelines includes using the 2015 version of CEHRT to meet the requirements of the promoting interoperability program (PIP) (Tables 3.7, 3.8). Each year, CMS provides updates to the eCQMs. These consist of updates regarding evidence-based medicine, code sets and measure logic.²³ The current measurement goals of eCQMs for both Medicare and Medicaid for 2019 include²³:

- Patient and Family Engagement
- Patient Safety
- Care Coordination
- Population/Public Health
- Efficient Use of Healthcare Resources
- Clinical Process/Effectiveness

With these new standards of cost-saving and healthcare safety, there have been many organizations developed to aid in quality improvement. These groups accomplished this by setting forth guidelines and metrics for facilities and providers to integrate into their care of patients. The tools they provide aid clinical informaticists to develop and implement system functionality to optimize clinical effectiveness and efficiencies. There are many, but two of the more significant ones include the National Quality Forum (NQF) and the Agency for Healthcare Research and Quality (AHRQ).

The NQF is an agency that supports improving overall national health by several methods: setting national standards, recommendation of measure for use in payment and public reporting programs, identification of quality improvement (QI) priorities, advancement of electronic measurement and providing information and tools to help healthcare decision-makers.²⁵ The tools provided by the NQF are especially helpful to healthcare providers when aiming to meet metrics and achieve both facility and personal goals. Table 3.9 provides a brief explanation of the tools provided.

The AHRQ is a U.S. government agency that functions as part of the Department of Health & Human Services (DHHS). Its primary mission is to support research and produce evidence for the improvement of quality healthcare. To achieve this, they developed quality indicators to determine the standards of healthcare and if certain providers are meeting those standards.²⁷ Examples of their goals are keeping patients safe, helping physicians and other healthcare providers improve quality, and develop data to track changes in the healthcare system (Table 3.10).

These metrics, such as average daily census, cervical cancer screening and diabetic eye exams, require a thorough investigation of the requirements as well as current and future state workflow assessments to ascertain how the metrics

Table 3.7 Eligible Professionals Objectives and Measures²⁴

Protect Patient Health Information	Protect ePHI created or maintained by the CEHRT through the implementation of appropriate technical, administrative and physical safeguards
Electronic Prescribing	Generate and transmit permissible prescriptions electronically
Clinical Decision Support (CDS)	Implement CDS interventions focused on improving performance on high-priority health conditions
Computerized Provider Order Entry (CPOE)	Use CPOE for medication, laboratory and diagnostic imaging orders directly entered by any licensed healthcare professional, credentialed medical assistant, or a medical staff member credentialed to and performing the equivalent duties of a credentialed medical assistant, who can enter orders into the medical record as per state, local and professional guidelines
Patient Electronic Access to Health Information	The EP provides patients (or patient-authorized representative) with timely electronic access to their health information and patient-specific education
Coordination of Care Through Patient Engagement	Use CEHRT to engage with patients or their authorized representatives about the patient's care
Health Information Exchange	The EP provides a summary of care record when transitioning or referring their patient to another setting of care, receives or retrieves a summary of care record upon the receipt of a transition or referral or upon the first patient encounter with a new patient and incorporates summary of care information from other providers into their EHR using the functions of CEHRT
Public Health and Clinical Data Registry Reporting	The EP is in active engagement with a public health agency or clinical data registry to submit electronic public health data in a meaningful way using CEHRT, except where prohibited, and in accordance with applicable law and practice

Table 3.8 Eligible Hospital or Critical Access Hospital Objectives and Measures²⁴

Protect Patient Health Information	Protect ePHI created or maintained by the CEHRT through the implementation of appropriate technical, administrative and physical safeguards
Electronic Prescribing	Generate and transmit permissible prescriptions electronically
Clinical Decision Support (CDS)	Implement CDS interventions focused on improving performance on high-priority health conditions
Computerized Practitioner Order Entry (CPOE)	Use CPOE for medication, laboratory and diagnostic imaging orders directly entered by any licensed healthcare professional, credentialed medical assistant, or a medical staff member credentialed to and performing the equivalent duties of a credentialed medical assistant, who can enter orders into the medical record per state, local and professional guidelines
Patient Electronic Access to Health Information	The EH/CAH provides patients (or patient authorized representative) with timely electronic access to their health information and patient-specific education
Coordination of Care Through Patient Engagement	Use CEHRT to engage with patients or their authorized representatives about the patient's care
Health Information Exchange	The EH/CAH provides a summary of care record when transitioning/referring their patient to another setting of care, receives or retrieves a summary of care record upon the receipt of a transition or referral or upon the first patient encounter with a new patient and incorporates summary of care information from other providers into their EHR using the functions of CEHRT
Public Health and Clinical Data Registry Reporting	The EH/CAH is in active engagement with a public health agency or clinical data registry to submit electronic public health data in a meaningful way using CEHRT, except where prohibited, and in accordance with applicable law and practice

Table 3.9 National Quality Forum Tools²⁶

NQF Graphics Library	Collection of downloadable graphics that can be used in your work
Alignment Tool	Helps you align, expand, or start your measurement and reporting efforts in ways that fit with key national programs
Health IT Knowledge Base	Provides answers to some of the most technical questions surrounding NQFs health IT and eMeasures initiatives
My Dashboard	Helps track what is happening at the NQF and lets you personalize your experience on the web
NQFs Action Registry	Online collaboration space designed to help people on the frontlines of making care sage connect with others, find new resources and help distribute proven ideas
Field Guide to NQF Resources	Dynamic, online resource designed to help those involved with measurement and public reporting more easily access basic information and NQF resources related to quality measurement

Table 3.10 Agency for Healthcare Research and Quality Areas of Focus²⁷

Project ECHO (Extension for Community Healthcare Outcomes)	AHRQ funded an innovative model, Project ECHO, for training and supporting primary care clinicians in rural communities to provide specialized care for their patients. This model has flourished and expanded from its initial focus on hepatitis C into new clinical areas, including mental health and substance abuse and HIV. It has also been adopted by the Veterans Health Administration as a tool for expanding access to high-quality care for veterans across the country.
Re-Engineered Discharge (RED)	RED is a structured protocol and suite of implementation tools that help hospitals rework their discharge processes to reduce readmissions by determining patients' needs and carefully designing and communicating discharge plans. Hospitals using these tools have seen a 30% reduction in hospital readmissions and emergency rooms visits.
Centers of Excellence	Three Centers of Excellence were funded to study how high-performing healthcare systems promote evidence-based practices in delivering care. The AHRQ project will help close this research gap and produce information that can be used by health systems throughout the United States to improve patient outcomes.

can be met within a CEHRT. The subsequent reporting on to government agencies for either reimbursement incentives or avoidance of penalties often becomes the primary goal. But workflow and ease of usability are factors that also need to be considered when asking providers and other healthcare professionals to aid in meeting these metrics. To accomplish this, often times the use of CDS systems will be brought into play.

Clinical Content and Decision Support Tools

Clinical informaticists and clinicians in general, have been making a significant impact in HIT since the late 1950s. Since then, there has been the development of mathematical models used to aid providers in diagnosing various medical conditions²⁸ to the present-day use of AI, application programming interfaces (APIs), substitutable medical applications reusable technologies (SMART), the fast healthcare interoperability resources (FHIR®), or a combination of several of these such as SMART on FHIR.

CDS is defined as “a category of concepts and methods designed to provide patient-specific clinical information to a healthcare provider at the point of care.”²⁹ The ultimate goal in the use of CDS is, of course, patient safety and improved patient experience. But, it can also serve other purposes. Establishing a robust and reliable process for developing best-practice maintenance of a CDS is paramount. Good build design and implementation can not only provide better patient outcomes but improved overall quality, reduced cost, improved documentation consistency and reliability, as well as an enhanced clinician experience. This is where clinical informaticists are paramount. They have the skills to translate workflow into the CDS design and build. Clinical informaticists have the ability to better communicate and understand all the challenges that clinicians face and that come along with new CDS, new implementation of any kind, within an electronic health record, “acceptance and adoption of CDS is critical for successful implementation.”⁴ CDS is typically implemented within an EHR, in the form of order sets, condition-specific clinical alerts, access to reference information (also known as info buttons) and passive/active generalized alerts. But, it can also be seen in use with patient portals, health information exchanges (HIEs), mobile applications and other HIT systems.

Considering it takes up to 17 years for translational research to make its way into clinical practice, maintaining current, evidence-based clinical content can be a challenge but is required for any successful use of CDS in the healthcare setting.³⁰ To maintain this rapidly changing use of not only technology, but medicine as well, skilled workflow assessments, governance and maintenance is a must. According to Butterfield, “medical knowledge doubles approximately every eight years, so a physician’s knowledge base is outdated very quickly after graduation from medical school. Keeping up with current knowledge by reading

Table 3.11 Advantages and Disadvantages of Computerized Provider Order Entry³³

<i>Advantages</i>	<i>Disadvantages</i>
Averting handwriting issues	Perceived as more work for clinicians
Drug/drug, drug/food, drug/allergy alerts	Provider coding requirements
Formulary recommendations	Bad use of CDS; design, maintenance
Safer or lower cost	Duplicate alert drop-down issue
Economic savings	Never-ending system demands
Better billing turn around	Hybridized paper/electronic workflows
Faster order transmission to lab/pharmacy/ radiology	Constantly changing evidence and technology
	Overdependence on CDS

journal articles is impractical due to the volume of material and lack of time for reading it.”³¹

To quote Dr. W. Edwards Deming of The Deming Institute, “a bad system will beat a good person every time.” No matter the amount of governance management, or expert opinion of the project informaticist, if the design and build are “bad,” the implementation will fail. Here, we look at some of the advantages and disadvantages of CDS^{32,33} (Table 3.11):

Advantages of CDS:

- Increased quality of care and enhanced health outcomes
- Avoidance of error and adverse events
- Improved efficiency, cost–benefit and provider and patient satisfaction
- Computerized practitioner order entry

Disadvantages of CDS:

- Alarm/alert fatigue
- Clinical burnout, documentation burden
- Delegation of order entry to other clinicians
- Data integrity
- Auto-population
- Design and implementation issues
- Lack of maintenance and governance

According to Bresnick, “CDS tools are designed to help sift through enormous amounts of digital data to suggest next steps for treatments, alert providers to available information they may not have seen, or catch potential problems...”³⁴



Figure 3.2 The five rights of clinical decision support³⁶

Osheroff et al. recommends a five-rights framework for CDS that has been adopted and promoted as best practice by the AHRQ³⁵ (Figure 3.2). There is also a need for increased usability. This relates directly to CPOE. The less a physician or advanced practice provider (APP) uses the order systems as designed, the less impactful CDS is. It will be alerting in the face of the incorrect people. So, our providers have to be well trained, well informed and satisfied with the usability of the system.

The five rights include (Table 3.12)³⁷:

- The right information
- To the right person
- In the right intervention format
- Through the right channel
- At the right time in the workflow

Table 3.12 Explanation of the Five Rights of CDS³⁶

<i>Right Information</i>	<i>Right Person</i>	<i>Right Format</i>	<i>Right Channel</i>	<i>Right Time</i>
Have the right decision-makers involved	Include the end-users and the healthcare team	Alerts; passive or actionable?	EHRs	When should the CDS be presented in the workflow?
Evidence-based, recognized guidelines	Determine who needs to actually see the CDS	Order sets, HIEs, patient portals	CPOE	Workflow analysis
Actionable, not too much information	Is the person seeing it qualified to use it?	Infobuttons	Forms, etc.	Close the loop

Ultimately, CDS is not going anywhere, anytime soon, “CDS tools are increasingly leveraging machine learning and artificial intelligence to sophisticated power analytics. Machine learning algorithms can ingest large quantities of data, identify patterns, and return detailed results to users.”³⁴

Clinical Data Analytics Tools

To put all of this together, clinical informatics is all about the clinical data; how do we enter it, where do we store it, what can we do with it? Whether it is a retrospective look at the data or more towards the future with predictive analytics, clinical informatics plays a vital role in healthcare. Considering what has been discussed related to data, CDS and quality measures, outcomes are a top goal and are necessary in order to meet the goals you have set for providers and facilities, including lowering cost and improving the patient experience. This consists of defining and understanding both clinical outcomes as well as the operational outcomes. Later chapters discuss the systems life cycle and data management in more detail. With all the regulatory and accreditation requirements (e.g., Joint Commission, DNV GL), the ability to develop and maintain a functional system of data management is challenging. According to McBride & Tietze, “data management, measures, and analytics are the foundations of improvement.”⁶ Data warehouses, retrospective storage of data, can include clinical and operational data.³⁸ See [Chapter 2](#) for more discussion surrounding data warehouses.

Clinical Outcomes

Clinical outcomes are somewhat different from typical outcomes measures. The clinical measurements are related to specific changes in health or health quality, as it relates to the healthcare a patient has received. They are measurable and can be evaluated through activity metrics such as hospital re-admission rates, or catheter-associated urinary tract infections (CAUTIs), as well as many other metrics.³⁹ Often times, facilities will benchmark or compare themselves to other comparable facilities based on a shared standard. This ranking is usually available to the public. It is easy to see why keeping up with data, and clinical outcomes would be considered vitally important.

Operational Outcomes

Operational outcomes are defined as outcomes that are specific and measurable statements about improvements a facility would like to make to its processes or services, “each outcome should flow directly from a more general goal of the unit.” For example, if an academic department has a goal

of increasing diversity, then the department might have separate outcomes addressing the recruitment of more diverse students and recruitment of more diverse faculty.⁴⁰

In the development of outcomes, the use of the acronym SMART is often recommended to assure a measurable outcome is designed.

Outcomes should be **SMART**:

Specific
Measurable
Attainable
Realistic
Timely

Common Data Analytics Tools

Now that you have all this data, how do you go about making it work for you? The process starts with learning about your data, manipulating it, creating information from it and then distributing that knowledge and wisdom to others. By determining what kind of data you have (nominal, ordinal, interval, ratio), you can examine or explore the data set. There are many tools available for data analysis, including Microsoft Excel, IBM SPSS, Tableau, business intelligence software and many more. When you have identified and opened your data file, you can start with a visual inspection⁶:

- What rows and columns do the data set reflect?
- How are the data structured?
- Are there visibly missing data apparent in the file?
- Do they appear to be sorted in some order?
- What variables in the data set represent dependent, independent and grouping variables?

In healthcare, it is not uncommon for there to be data integrity issues or problems with the accuracy or validity of the data over its lifecycle.⁴¹ This can often occur for various reason. Some of the more common ones are listed here:

- Wrong patient data
- Height/Weight inaccuracies impacting drug calculations
- Allergies and medications documentation inaccuracies or omissions
- “Fat finger” errors, physical typing/entering the wrong data
- Overall missing data; forgetting, time constraints, fraudulent documentation
- Not documenting real time (e.g., sepsis alert dependent on vital signs data entry)

Table 3.13 Common Data Analytics Tools and Terminology³⁸

<i>Tool</i>	<i>Purpose/Definition</i>	<i>Example</i>
Fields	Vertical column in a database that contains data with common characteristics for the entire record	"First Name" "Last Name" "Date of Birth"
Records	Horizontal rows in a database containing different pieces of data belonging to a given entity	All of the fields related to the row of "Billy"
Tables	Consists of all records; combinations of all fields and records together	All horizontal and vertical rows together
Reports	Alternate view of data; typically assembled from a query	Generally generated on paper, can also be electronic for distribution of data
Query	Process of selecting desired records; pulling the data	Pulling data related to all female patients older than 50 with a history of colon polyps
Graphs and Charts	Tool for examining and presenting data	Scatter plot, pie charts, bar charts, flowcharts
Control Charts	Tool for looking at a process over time	Common and special-cause variation, upper and lower control limits
Predictive Modeling	Instead of retrospective data analytics, the data is used to predict future outcomes	Pulling last five years of financial data to predict next years' budget needs

Based on these examples, it is not hard to understand the value of inspecting your data prior to presenting it. With that, the ability to recognize clinical and operational outcomes through the use of various data analytics tools (e.g., reports, tables, graphs, charts, predictive models) is a necessary skill set for any clinical or healthcare informatics specialist. Here are some examples of the more common data analytics tools and terminology ([Table 3.13](#)).

Summary

The future of healthcare and clinical informatics is wide open. Like medicine, informatics and technology is ever-changing in its day-to-day advancements. Big data is booming, and we are all running to keep up. This, along with project management, evidence-based CDS and mobile technology will keep this

profession chaotic and busy for many years to come. It can be anticipated that the field of clinical informatics will continue, and certified nurses, physicians, radiologists, respiratory therapists, pharmacists, as well as other healthcare professionals will be the ones to lead this aspect of healthcare into the future.

References

1. HIMSS (Healthcare Information and Management Systems Society). 2019. HIMSS Dictionary of Health Information and Technology Terms, Acronyms and Organizations. 5th ed. Chicago: HIMSS, p. 40.
2. Columbia University. n.d. *Clinical informatics*. Retrieved from <https://www.dbmi.columbia.edu/research/research-areas/clinical-informatics/> (accessed July 21, 2019).
3. Nole D. 2018. 5 Healthcare trends to watch in 2019. *Becker's Hospital Review*. Retrieved from <https://www.beckershospitalreview.com/healthcare-information-technology/5-healthcare-trends-to-watch-in-2019.html>
4. Cummins MR, Gundlapalli AV, Murray P, Park HA, Lehmann CU. 2016. Nursing informatics certification worldwide: History, pathway, roles, and motivation. *Yearb Med Inform*. 264–271 (accessed August 2, 2019).
5. Lehmann CU, Gundlapalli AV, Williamson JJ, Fridsma DB, Hersh WR, Krousel-Wood M, Ondrula CJ, Munger B. 2018. Five years of clinical informatics board certification for physicians in the United States of America. *Yearbook of Medical Informatics* 27 (1): 237–242. doi:10.1055/s-0038-1641198.
6. McBride S, Tietze M. 2019. *Nursing Informatics for the Advanced Practice Nurse: Patient Safety, Quality, Outcomes, and Interprofessionalism*. New York: Springer Publishing Company.
7. American Medical Informatics Association [AMIA]. n.d. Global health informatics working group. Retrieved from <https://www.amia.org/programs/working-groups/global-health-informatics> (accessed March 1, 2020).
8. Pettit L. 2018. Why Canada? Health Information Management Systems Society. Retrieved from <https://www.himss.org/resources/himss-in-canada> (accessed March 2, 2020).
9. EU*US eHealth Work. 2018. Welcome to EU*US eHealth Work: Measure, inform, educate, advance. Retrieved from <http://www.ehealthwork.eu/> (accessed March 11, 2020).
10. Gardner RM, Overhage JM, Steen EB, Munger BS, Holmes JH, Williamson JJ, Detmer DE. 2009. Core content for the subspecialty of clinical informatics. *J Am Med Inform Assoc* 16 (2): 153–157. doi:10.1197/jamia.M3045.
11. American Institute of Medical Sciences & Education. *All Essential Medical Terms in One Place*. Retrieved from <https://www.merriam-webster.com/dictionary/prefix> (accessed July 16, 2019).
12. Merriam-Webster. Prefix. Retrieved from <https://www.merriam-webster.com/dictionary/prefix> (accessed July 16, 2019).
13. Drugs.com. Prescription Abbreviations. n.d.. Retrieved from <https://www.drugs.com/article/prescription-abbreviations.html>
14. Fogoros RN. *The Most Common Physician Specialties*. Retrieved from <https://www.verywellhealth.com/types-of-doctors-1736311> (accessed July 6, 2019).
15. National Health Information Infrastructure. n.d. Standards and standards organization. Retrieved from <http://www.aspe.hhs.gov/sp/nhii/standards.html>
16. CMS.gov. 2018. ICD-10. Retrieved from <https://www.cms.gov/Medicare/Coding/ICD10/>